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Sleep deprivation in adolescents: correlations with health complaints and health-related quality of life

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Highlights

- **Sleep deprivation was present in 18.9% of the adolescents.**
- **There was a very high variability in sleep schedules.**
- **Sleep problems were reported in 37.2% of the adolescents.**
- **Health complaints prevalence was higher in sleep-deprived adolescents, with special reference to shoulder and neck pain, fatigue and dizziness.**

Abstract

Objective: The present study aimed to evaluate the influences of sleep duration, sleep deprivation, and weekend variability of sleep upon other adolescents' features, namely those related to health and health-related quality of life. Furthermore, other factors that contribute to health complaints, such as age and gender, were evaluated.

Methods: The Health Behaviour in School-Aged Children (HBSC) survey is based on a self-completed questionnaire. The participants in the present study were 3476 students (53.8% were girls) in the 8th and 10th grades at school; the mean age was 14.9 years (range 12.5 to 19.0). Subjective sleep duration during the weeknights and weekends was collected; sleep deprivation (SD) was considered whenever the difference was greater than 3 h. Health complaints frequency (headaches, backache, fatigue, sadness, irritability, anxiety and difficulty in falling asleep) and health-related quality of life (with the Kidscreen 10) were collected.

Results: Sleep deprivation was present in 18.9% of the students. It was negatively correlated with sleep duration on weeknights. There were no gender differences, but SD increased with age and grade. Higher school grades were mainly associated with fatigue. A considerable number of adolescents had sleep problems (37.2%); 25.5% had difficulties in sleep initiation, which was more prevalent in adolescents with SD. The sleep duration on weeknights was decreased in the SD group. The average health-related quality of life was reduced in adolescents with SD. The frequency of headaches, fatigue, irritability, nervousness, shoulder

pain and dizziness was higher is adolescents with SD, but the odds ratio values were relatively low, with the exception for shoulder/neck pain, fatigue and dizziness. Girls had significantly more health complaints than boys, with special focus on headaches.

Conclusions: Sleep deprivation is associated with the perception of health-related quality of life and perceived physical and mental health.

Keywords:

Sleep deprivation

Headaches

Pain

Fatigue

Health-related quality of life

Adolescents

Introduction

The aim of the present study was to provide an in-depth analysis of the diverse associations between sleep duration, sleep deprivation, and variability in sleep duration between weekday and weekend nights, and health and health-related quality of life.

In the present review, the most common health complaints of adolescents are addressed. A brief revision of the main sleep parameters (duration, variability, deprivation, late bedtimes and eveningness) that impact upon the health of adolescents is made, taking into account any possible geographical/cultural influences.

Health issues in adolescents are an important public-health concern, with sleep habits playing an important role. In the last few decades, several studies of children and adolescents have pointed out the relations of sleep duration with: daytime sleepiness [1,2,3]; BMI (body mass index) [2,4,5,6,7]; type II diabetes and insulin resistance [8]; specific sleep disorders [1]; health characteristics [2]; high blood pressure [9]; pain [10,11,12]; race [2,8]; cognitive tests and academic success [3,13,14,15]; subjective psychological well being [16]; socioeconomic status [2,5]; habits such as high screen- or TV-viewing time [5,16]; low or moderate physical activity [5,17]; poor dietary intake and quality [18]; and risk-taking behaviors [19,20,21,22] namely, binge drinking [23].

In a recent meta-analysis of children and adolescents aged from 9 to 18 years, including 23 countries, sleep duration varied with gender, age and geographical region [24].

School-day sleep differed slightly between boys and girls – girls slept for 11 min/night more than boys (p<0.003), and 29 min more on non-school days (p<0.003). Sleep time declined with age – minus 14 min/day per year of age on school days, and 7 min on non-school days. Asian adolescents sleep 40 to 60 min less each night than Americans, and 60 to 120 min less than Europeans [24]. In India, the mean sleep duration was 7.8 h, and it also decreased with age [24], and in China, 34.2% of the students had complaints of poor sleep [26].

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In trying to identify predictors of sleep duration and variability in a community-based cohort study of 247 adolescents (48.5% female, 54.3% ethnic minority, mean age of 13.7 years), univariate models have demonstrated that age, minority ethnicity, neighborhood distress, parent education, parent income, pubertal status, and BMI were significantly related to variability in the total sleep time. In the multivariate model, age, minority status, and BMI were significantly related to variability in total sleep time (all with p<0.05), with younger adolescents, non-minority adolescents, and those of a lower BMI obtaining more regular sleep [2].

In a Taiwan population, the mean sleep duration on weeknights was 7.35 ± 1.23 h and on weekends 9.38 ± 1.62 h, and weeknight sleep decreased significantly with increasing school grade; there was a trend towards increased daytime sleepiness for students in higher school grade levels. Pearson correlation showed a significant negative correlation (p=0.0001) for increasing total sleep time on the weekend and decreasing BMI [1].

The Cleveland Children's Sleep and Health Cohort, which consisted of 471 adolescents with a mean age of 15.1 years, sleep duration, measured by actigraphy, had a quadratic 'u-shape' association with HOMA (homeostasis model assessment of insulin). When adjusted for age, gender, race, preterm status, and activity, adolescents who slept for 7.75 h had the lowest predicted HOMA, and for adolescents who slept 5.0 h or 10.5 h, the

HOMA indices were approximately 20% higher; after adjusting for adiposity, only the association with longer sleep persisted [8].

The relation between sleep duration and health goes beyond weight/obesity and insulin/insulin resistance; sleep intervenes in a significant number of clinical complaints including headache and chronic pain of different characteristics, which are either widespread, musculoskeletal, visceral and more. In depression and multiple somatic complaints, this sleep impact or association is often multiple, with clusters of symptoms fluctuating together with bilateral influences and a comorbid profile [27,28]. Insomnia and short sleep duration are comorbid with: obesity, metabolic syndrome, growth hormone deficiency, allergic conditions, chronic pain, neoplasms, blood malignancies, genetic and congenital disorders. Hypersomnia is comorbid with malignancies. Sleep apnea is comorbid with: obesity, metabolic syndrome, polycystic ovarian syndrome, hypothyroidism, asthma, epilepsy, ENT (ear/nose/throat) disorders, congenital malformations and genetic conditions. Parasomnias imply a differential diagnosis with epilepsy, and some of them are more prevalent in migraine [27].

In Finland, using a very large sample of adolescents (*n*=384,076) aged from 14 to 20 years, it was proven that late bedtimes, especially after 23:30, increase the prevalence of depression, accidents, neck or shoulder pain, low back pain, stomachache, anxiety or nervousness, irritation or tantrums, headaches, tiredness or dizziness [29]. The high prevalence of headache, depression and atopic conditions in adolescents not getting enough sleep the week before the study was also proven in a large epidemiological study in the USA [30].

A relation exists between headaches and sleep, but with complex expressions, since headaches can be triggered by too much or too little sleep, and also by irregularity or changes in sleep schedules [31,32]; the complexity and bidirectional relations between sleep problems and headache have also been proven in a couple of studies performed on adolescents. In 800

Italian adolescents, the prevalence of headaches was very high (45.6%) and was associated with irregular intake of meals (especially irregular breakfast) and sleep disturbances [33]. In a smaller sample of 69 adolescents with primary headaches, the presence of sleep disturbances was significantly high, namely insufficient total sleep (65.7%), daytime sleepiness (23.3%), difficulty falling asleep (40.6%), and night waking (38.0%) [34]. The same type of results were obtained in a larger sample (*n*=1862) of adolescents in New Delhi; sleep disturbances in migraineurs was more common when compared with tension headache sufferers and controls [25]. The relations with migraine and non-migraine headaches was also proven in a sample of 1023 youngsters aged 8 to 15 years: migraineurs had higher scores of daytime sleepiness and were more often evening types [35]. Furthermore, among the triggers of pediatric migraine, lack of sleep was reported in 69.6% of the individual cases, only surpassed by stress, which accounted for 75.7% [36]. A lower percentage and opposite effects were found by Bruni et al. in 2008 [35]: 'bad sleep' was an headache trigger in 32.32% of migraine and non-migraine adolescents, while emotional distress accounted for 27.8% of the cases; in spite of that, the objective risk factors for headache (alcohol and coffee consumption, smoking, neck pain, stress and physical inactivity) did not include sleep [37].

Sleep is also a major influent factor in adolescents with chronic pain. Insufficient sleep quantity or quality was an independent risk factor for persistence of neck and low back pain among girls [11] and for chronic pain [12]. Pain affects around 21% of adolescents [38]. The relations between chronic pain and sleep disturbances or insomnia are mutual, with insomnia being a risk for pain chronicity, while pain, poor sleep hygiene and higher depressive symptoms are the main risks for insomnia persistence [39,40]. The comorbidity between sleep disturbances and chronic pain was shown in a group of 1518 adolescents aged 11 to 19 years old, with a joint prevalence of 19.1% [41]. Furthermore, low sleep efficiency predicts next day pain, while the vice versa prediction does not hold [10,42]. The prevalence

of neck and shoulder pain is higher in girls; the risk factors are multiple, namely: family history, school furniture, long sitting time and computer use, insufficient rest time, sleep duration, transportation type, schoolbag weight and smoking [43].

Sleep problems are common (circa 45%) in pediatric functional gastro-intestinal disorders [44]. Adolescents suffering from irritable bowel syndrome have increased percentages of 'poor sleep' [26], and in a clinical group of 25 adolescents with recurrent abdominal pain, 29% of them reported awakenings related to pain, and in 75% of them, the quality of sleep was not good [45].

Fatigue is another important associated symptom. It is often associated with chronic pain [46], depression [46,47], and with insomnia or sleep problems [28,46,47]. The risk factors for fatigue with poor clinical outcome are: sleep problems, somatic complaints, blurred vision, pain in the arms or legs, back pain, constipation and memory deficits. The indicators of a good outcome are: male gender and a physically active lifestyle [48]. Fatigue is statistically associated with feeling depressed, breakfast habits, not being well in school, low physical training, no adult to talk to, having bullied someone, shoplifting and physical fighting [47]. In pediatric fibromyalgia, the dominant symptoms occurring in almost 90% of the children are diffuse pain and sleep disturbances [49].

In adolescents, the mutual interaction of depression and sleep also exists; it has also been demonstrated in people with chronic pain [50,51] 450,51 .

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Wellbeing and health-related quality of life (HRQoL) in children and adolescents is a quite recent concept [50]. It is important to consider this concept within an ecological perspective through multiple levels of analysis, namely: self-perceptions and family perceptions [53]. Children's perceptions of their HRQoL are influenced by several factors,

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such as gender, age, personal and family characteristics, psychological toughness, as well as their socio-economic status (SES) [54,55,56,57].

Healthy sleep is fundamental to human health and quality of life [58,59], and sleep deprivation increases the risk for mood and behavioral problems, such us drug and alcohol use and vulnerability to accidents [19,20,21,22,60].

Links between eveningness and poor physical, social/interpersonal relationships and mental health have also been found [61]. Adolescents with less-healthy sleeping patterns present with lower scores on emotional, social, school, psychosocial functioning and global quality of life [62,63], and those who are sleep deprived experience less positive and more negative effects [64]. Those with delayed sleep phase disorders have higher trends for alcohol and caffeine consumption, and lower sports participation [65].

Sleeping for 6 h or less per night is linked to symptoms of depression and lower self-esteem [66]. Sleep deprivation is associated to deficits in child and adolescent functioning, and global health [67,68]. Children and adolescents who sleep for less than 5 h per night present with more feelings of stress, depression and suicidal ideation [69,70].

Objectives

To evaluate the interactions between sleep deprivation in adolescents and age, gender, school grade, BMI, health complaints and health-related quality of life; it was hypothesized that sleep deprivation is associated with a higher prevalence of health complaints.

Methods

Participants

The present survey is a component of the Health Behaviour in School-Aged Children (HBSC) study [71,72,73,74].

The Portuguese HBSC survey included 3476 pupils; 53.8% (*n*=1869) were girls, in the 8th (45.9%) and 10th grades (54.1%), with a mean age of 14.9 years (SD = 1.26, range 12.5 to 19.0). The children were randomly chosen from 139 schools, in a national sample that was geographically stratified by Education Regional Divisions. The school response rate was 89.9%. The overall procedure has been described elsewhere [71,74]; briefly, this study has the approval of a scientific committee, an ethical national committee and the national commission for data protection, and it strictly followed all of the guidelines for protection of human rights. The adolescents' participation in the survey, and completion of the questionnaires was voluntary and anonymity was assured.

Instrument

The present study used a Health Behaviour in School-Aged Children (HBSC 2010) questionnaire [73] and inquired about: (1) gender and age; (2) socio demographics and self-reported BMI; (3) sleep duration during the weeknights and weekends, and sleep deprivation (defined as a difference in sleep duration equal to or more than 3 h between weeknights and weekends, which corresponds to the average difference plus 1 SD, rounded to 0 decimals); (4) health complaints (headaches, backache, fatigue, sadness, irritability, anxiety and difficulty in falling asleep); (5) health-related quality of life, measured by the Kidscreen 10 Portuguese version (Kids 10) [56,75]. The questions were either closed or Likert scale types [73,74].

The continuous variables used in the study were: age (A), BMI, sleep duration during the week (SWeek), sleep duration during weekends (SWE), the difference between both (DifWE-W) and Kids 10. The discontinuous variables were: gender (M/F), grade (8th or 10th), sleep deprivation (SD), headache, abdominal pain, backache, shoulder/neck pain,

fatigue/exhaustion, sadness, irritability, nervousness, sleep initiation problems, and dizziness. The frequencies of complaint occurrence were: daily, weekly, monthly, and rare.

Statistical analysis

The analysis included descriptive analysis and analysis of variance for continuous variables: age (A), BMI, sleep duration during the week (Sweek), sleep duration during weekends (SWe), the difference between both (DifWe-W), and Kids 10.

The Pearson Chi-squared test was used to compare: age, gender, sleep duration during the week (SWeek), sleep duration during weekends (SWE), the difference between both, BMI and Kids 10, with the *Z* transformation of frequency of occurrence of each health complaint. Risk analysis implied subdivision of health complaints into two categories: Catagory 1 (Yes) daily, several times per week, weekly complaints; Catagory 2 (No) no complaints, inexistent or with low frequency. Sleep deprivation (Yes/No) was the DifWe-W if it was 3 h or more. Pearson correlation coefficient and contingency coefficients were computed assuming a *Z* distribution; the odds ratios and the corresponding confidence intervals were calculated. Effect sizes were evaluated by Eta^2 computation. The nominal level of significance was 0.05. SPSS@ (IBM corporation, Armonk NY, USA) version 21.0 for Windows was used in these calculations.

Results

The continuous variables concerning age, BMI, SWeek, SWE, DifWE-W, Kids 10 and SS, together with gender and school grade, are presented in Table 1; for each of them, the comparison for the SD condition is shown. A total of 14.2% of the students were overweight and 2.7% were obese. The percentage of students having a difference of 2 h sleep is 27.5% and equal/more than 3 h is 18.9%. Sleep duration on weeknights was curtailed in 38.5% and

increased in 5.8% of the students, taking the normative values for age as reference [80]. During weekends, 42.6% slept more than 10 h. There were no significant differences between boys and girls. Data show that age, grade, BMI, SWE are significantly higher, and Kids 10 are significantly decreased with SD, but with very low eta^2 values; however, the DifWE-W is significantly higher and sleep duration significantly lower in the SD group with high and moderate size effects, respectively.

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A significant percentage of the adolescents had frequent difficulties in sleep initiation (25.5%) and clear sleep problems (37.2%). Adolescents with sleep deprivation have significantly more problems with sleep initiation (Chi-squared = 50.463; p<0.001). The subsequent data analysis includes the descriptive variables together with the Pearson correlation analysis, assuming the presence/absence of sleep deprivation as a dependent variable, together with evaluation of size effects and risk analysis.

Regarding health complaints, the data show that pain complaints are frequent (weekly or more often), and some, such as back pain and shoulder pain, affect around 24 and 19.7% of the students, while headache occurs regularly in 22.2% (see Table 2). Equivalent percentages are observed in emotional symptoms such as sadness, irritability and nervousness. However, fatigue (39% of the students) and headache were the most frequent complaints. Dizziness and abdominal pain were less frequent, with prevalence between 10% and 15%. The presence of sleep deprivation increased significantly with the prevalence of some of these symptoms, such is the case for headaches (Chi-squared = 13.044; p<0.01); fatigue (Chi-squared = 28.697; p<0.001; irritability (Chi-squared = 16.48; p<0.01); nervousness (Chi-squared = 13.503; p<0.001), neck and shoulder pains (Chi-squared = 18.048; p<0.001); dizziness (Chi-squared = 18.718; p<0.001). Sleep deprivation did not influence backaches, abdominal pains and sadness. In spite of this, the eta^2 values were generally small, showing that the differences relate mostly to the large sample size. The association between SD and health complaints by

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OR analysis shows that only pain in the neck and shoulders, fatigue and dizziness have odds higher than 1.5.

The risk of having a health complaint was also computed in a 2 x 2 matrix using nominal variables for both gender and grade (see Tables 3 and 4). All of the health complaints that were investigated were significantly more frequent in girls, with an increased risk ranging from an OR = 1.561 in irritability to OR = 2.675 in headache. The values of eta^2 were mostly moderate for headache ($eta^2 = 0.192$). The increase with grade was also present for all variables; fatigue had the highest risk of increasing with school progression (OR = 1.734), but again, with the exception of fatigue, eta^2 values were small, showing that the obtained differences were mostly related to the sample size.

Conclusions and Discussion

The present study obtained indicators of adolescents´ health complaints and health-related quality of life during the 8th and 10th grades, and correlated them with sleep deprivation. It is integrated in a multinational WHO research project [72]. Data were obtained randomly and they were nationally representative; the response rate was quite high, and the percentage of missing data per answer was small. From the questionnaire structure, one aspect must be specially mentioned: the ability to measure both common health complaints and the health-related quality of life. The questions related to sleep were relatively simple: they implied the self-reported sleep duration during weeknights and weekends and the difficulties in sleep initiation. In spite of that, they allowed the evaluation of sleep deprivation, which was used as a dependent variable in both the non-parametric tests and risk analysis.

The study had two main limitations: the lack of information of sleep schedules during weeknights and weekends, which prevented evaluation of late bedtimes, and the use of subjective measure on sleep duration without objective comparisons. The reliability of the subjective evaluation of sleep duration has been questioned; however, in a recent study it has

been shown that adolescent´s reports are reliable, with no major differences with actigraphic measurements [77]. In line with other studies, the 3 h difference between weekend and weekday sleep duration proved to be a robust measure that was not influenced by sample size ($eta^2 = 0.797$), while showing a marked sleep reduction on weeknights. Subjective health complaints were used, but it must be stated that they are, by their nature, essentially subjective.

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The main conclusions can be summarized as follows: (1) the average sleep duration is low during weeknights and weekends, and there is a marked variability – sleep curtailment was observed in 38.5% of the adolescents, and SD, defined as a difference equal or more than 3 h between weekends and weeknights, was present in 18.9% of the students; (2) SD was negatively correlated with sleep duration on weeknights, without gender differences, but its percentage increased significantly with age and grade; (3) a considerable number of adolescents had sleep problems (37.2%), and 25.5% of them had difficulties in sleep initiation, which were more prevalent in sleep-deprived adolescents; (4) The Kids 10 were decreased in the SD group, but with marked effect sizes, while the difference between weekends and weeknights was significantly increased; (5) health complaints were rather frequent, with a higher prevalence for headaches and fatigue, followed by pain (back, neck, shoulder and gastric), emotional complaints (sadness, irritability and nervousness) and dizziness (the risks of all of them were influenced by age or grade); (6) the frequency of headaches, fatigue, irritability, nervousness, shoulder pain and dizziness was significantly higher in adolescents with SD, but with relatively low odds – the influence of health complaints upon sleep therefore remains an open issue; (7) all health complaints increased with grade, with special reference to fatigue; (8) female gender significantly increased the odds ratio of all health complaints, mainly for headache.

The mean sleep duration on school nights (7.52 h ± 1.16) in the present study was lower than recommended for age – weekend nights had longer sleep duration and higher variability (8.78 h ± 1.42); individually, it was reduced in 38.5% of the teens. Such a reduction is in line with worldwide studies concerning the secular trends in sleep reduction for children and adolescents [75]; however, taking into account the marked differences observed across age progression and the rapid changes resulting from the technological gadgets impacts, comparison with other countries and studies is neither straightforward nor easy. According to a recent meta-analysis in 23 countries and several continents, the obtained average sleep duration in this study, both during school and non-school days, is lower than the data from Europe, Australia and USA, and similar to the data obtained in Asian countries [24]. In the USA, in adolescents of comparable age, the sleep duration varies between studies: it is lower in the Youth Risk Behavior survey from 2007 to 2009, with average values of 6.7 h (95% CI 6.7 to 6.8) for females and 6.9 h (95% CI 6.8 to 6.9) for males [79]. It is reasonably higher in other studies: 7.91 h ± 0.04 in a group of 13,518 adolescents aged between 12 and 18 years, with 34.33% of them sleeping less than 8 h [80]; in a group of 387 students from the 9th to the 12th grades it was 8.10 h [81] and 7.7 ± 0.9 during week nights and 9.3 ± 1.4 [82]. In India, the mean sleep duration was 7.8 h [25]. Australian normative data from adolescents aged 14 years show that boys sleep during school nights 9:24 h ± 1.24, and 9:54 h ±1:32 on non-school days, while girls sleep 9:27 h ± 1:08 and 9:51 h ± 1:34, respectively [83]. In a Portuguese study that was restricted to the district of Viseu, adolescents aged 14 years (*n*=210) had sleep duration on weeknights of 8:17 h ± 1:17 for boys and 8:11 h ± 1:12 for girls [84], which are also somewhat higher than in the present study.

As in many other studies, sleep duration in the present study decreased with age, but it was also clear that the prevalence of health complaints increased with age. These data deserve further discussion. It is questionable whether health deteriorates so rapidly in 2 years in a sort of decaying process; therefore, it can be argued that adolescents might suffer from important

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pressures either from school, family or society, which by themselves deteriorate health and wellbeing. This unanswered issue deserves evaluation in future studies.

It is currently considered that girls sleep more than boys during adolescence [24]. The existence and absence of gender differences in sleep deprivation of adolescents is likely to be influenced by cultural issues; in fact, in the same country, girls sleep more than boys in public schools and less in private schools [85]. The relevance of such differences relies mostly in gender-specific risks, which have been described for sleepiness [86], obesity [82] and insomnia [84] and, in this study, for a higher prevalence of health complaints. Gender differences are often attributed to hormonal changes, but cultural issues together with psychological and organic factors remain open questions.

The high prevalence of sleep problems is, however, lower than what has been described in South Australian adolescents (66%) [81], but it is in line with other studies [1,81]. The difficulty in sleep initiation (25.5%) is, however, higher than the prevalence obtained in several other studies, which range from 5.6% to 19% [68,87,88].

The data obtained for BMI and sleep are in line with the vast majority of studies in the literature for adolescents [2,6,7,89] and children [4,5,89]; however, the impact of SD upon increased reported BMI was not clearly demonstrated in the present study.

The results concerning health-related quality of life deserve specific discussion, because there are few studies correlating sleep and health-related quality of life in adolescents, and measurement with tools specifically directed towards adolescents are still less frequent. Therefore, the obtained data seem particularly relevant and suggest the existence of a cluster of health symptoms, sleep restriction, habits and others with negative impact upon health-related quality of life starting as early as the second decade.

The physical and mental health components, including headaches, fatigue, body pains, somatic symptoms and emotional complaints, also start early in life. The high prevalence of

subjective complaints of frequent headaches measured in the present study (22.2%) is in line with others studies [33]. The prevalence of back, neck and shoulder pain is very high in the present sample, which is also similar to other studies [38], but as found in other studies, pain complaints increased in adolescents with SD adolescents [41], which can lead to comorbid states [39,40]. Fatigue, which is often associated with chronic pain, was the most prevalent complaint, and in the present study was also common in boys (34.6%).

Depression is often associated with insomnia or sleep deprivation [66-70]. In the present study, the feeling of sadness, and not depression itself, was evaluated. Sleep deprivation did not influence sadness, while nervousness was more common in adolescents with SD, but SD did not increase the risk. Irritability was, however, significantly more common in teens with SD and SD significantly increased its risk.

Sleep variability and irregular sleep schedules, during school days and non-school days, are common during adolescence [2]. In the present study, sleep variability, in all its components, was not evaluated because only the difference between weeknights and weekends was measured; this difference proved to be an important indicator of sleep deprivation.

The observed impact upon health and quality of life has important clinical implications. There is a need for concomitant evaluation of sleep schedules, which might cause correlate of aggravate the subjective complaints upon health. As previously stated, health deteriorates from the 8th to the 10th grade; this requires further research in order to identify the causes and to evaluate the lifelong consequences.

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The present data concerning sleep are also relevant both in terms of public health and future education campaigns and strategies. Parents play an important role in children and adolescents sleeping habits. The close relationship between sleep quality, and physical,

mental and social health highlights the need for intervention programs related to sleep-health-pattern promotion [90,91].

Furthermore, future research and more-sophisticated methods are required, namely: studies implying longitudinal observations, using quantitative or validated measures of sleep, and sophisticated statistical models that go beyond statistical associations and risks, trying to identify models and causal factors. Some of these steps are currently being taken by the HBSC team and in many research groups worldwide.

Conflict of interest

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Comment [JM17]: Please supply other information, as in your other references

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Comment [JM19]: Please check this reference, why are there two publications listed with two diferente years?

Comment [JM20]: Does this editor have an initial?

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Comment [JM28]: Please list first SIX authors, then use et al.

Comment [JM29]: Please list English translation in squre brackets after the orginal title

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Comment [JM32]: Is there a page range?

Table 1. Age, BMI and sleep-related variables; ANOVA and Chi-squared by sleep deprivation (SD) condition (*N*= 3195)

	Mean	St Dev	Presence of sleep deprivation (SD)		No presence of sleep deprivation (No SD)		F	Eta^2	*p*-value
			Mean	St Dev	Mean	St Dev			
Age	14.91	1.253	15.28	1.239	14.82	1.234	66.47	0.020	0.000
BMI	20.91	3.43	21.24	3.567	20.79	3.387	7.611	0.002	0.006
Sleep duration									
Hours of sleep (weeknights)	7.52	1.16	6.33	0.780	7.81	1.045	1079.75	0.253	0.000
Hours of sleep (weekends)	8.78	1.42	9.77	0.488	8.55	1.459	409.60	0.114	0.000
Difference weekend/week nights	1.25	1.59	3.43	0.672	0.73	1.285	2511.31	0.787	0.000
HRQoL									
Kidscreen 10	38.63	5.83	37.99	5.663	38.80	5.849	9.12	0.003	0.003

Gender	**Presence of sleep deprivation (SD)**	**No presence of sleep deprivation (No SD)**	**Chi-squared**	***p*-value**
Females	19.3%	80.7%	0.558	ns
Males	18.5%	81.5%		
Grade				
8th	12.7%	87.3%	67.323	0.000
10th	24.1%	75.9%		

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Table 2. Health factors: a basic descriptive analysis and distribution according to sleep deprivation condition, effect size values and odds ratios, with the corresponding confidence levels

Health complaints	+/- Daily	Weekly	Monthly	Rare		SD (%)	No SD (%)		Chi-squared	Eta^2	*p*-value	Odds ratio	Confidence levels
Headache (*n*=3181)	4.2	18.0	17.3	60.5		44.4	38.4		13.044	0.052	0.011*	1.357	1.107 to 1.663
Abdominal pain (*n*=3174)	1.5	6.7	14.1	77.6		10.3	7.6		4.410	0.037	0.054 ns	1.378	1.021 to 1.861
Backaches (*n*=3172)	6.8	17.2	19.6	56.4		28.5	23.3		9.421	0.047	0.055 ns	1.308	1.072 to 1.597
Pain in the neck and shoulders (*n*=3172)	4.6	15.1	16.6	63.7		25.4	18.5		18.048	0.069	0.001 ***	1.510	1.22 to 1.862
Fatigue (*n*=3180)	9.7	29.3	23.9	37.0		48.3	37.3		28.697	0.088	0.000 ***	1.570	1.313 to 1.877
Sadness (*n*=3172)	4.9	18.2	20.5	56.4		25.7	22.6		2.716	0.029	0.056 ns	1.188	0.968 to 1.458
Irritability/ bad temper (*n*=3175)	3.6	21.9	27.4	47.1		31.5	23.9		16.48	0.069	0.002 **	1.464	1.205 to 1.778
Nervousness (*n*=3177)	6.3	25.9	28.7	39.2		34.8	31.6		13.503	0.027	0.009 **	1.157	0.960 to 1.395
Dizziness (*n*=3175)	1.9	7.2	7.9	83.0		13.2	8.1		18.718	0.069	0.001 ***	1.717	1.303 to 2.261

ns, not significant; $p<=0.05$*; $p<=0.01$**; $p<=0.001$***

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Table 3. Health factors: a basic descriptive analysis and distribution according to gender, effect size values and odds ratios, with the corresponding confidence levels

Health Complaints	**Males**	**Females**		**Chi-squared**	**Eta^2**	***p*-value**	**Odds ratio**	**Confidence levels**
Headache (*n*=3458)	13.6	29.6		127.666	0.192	0.000***	2.675	2.247 to 3.184
Abdominal pain (*n*=3452)	5.4	10.8		31.456	0.095	0.000***	2.092	1.607 to 2.719
Backache (*n*=3448)	19.1	29.0		44.831	0.114	0.000***	1.730	1.472 to 2.033
Pain in the neck and shoulders (*n*=3329)	15.7	24.3		36.646	0.105	0.000***	1.720	1.442 to 2.053
Fatigue (*n*=3335)	34.6	45.8		39.525	0.109	0.000***	1.571	1.364 to 1.809
Sadness (*n*=3451)	17.8	29.9		63.750	0.136	0.000***	1.948	1.652 to 2.298
Irritability/bad temper (*n*=3454)	22.2	31.1		31.310	0.095	0.000***	1.561	1.335 to 1.825
Nervousness (*n*=3455)	26.5	41.2		74.594	0.147	0.000***	1.905	1.644 to 2.207
Dizziness (*n*=3452)	6.0	13.1		45.645	0.115	0.000**	2.367	1.832 to 3.058

p<=0.05*; *p*<=0.01**; *p*<=0.001***

Table 4. Health factors: a basic descriptive analysis and distribution according to grade, effect size values and odds ratios, with the corresponding confidence levels

Health complaints	8th Grade	10th Grade		Chi-squared	Eta^2	*p*-value	Odds ratio	Confidence levels
Headache (*n*=3413)	19.1	25.3		22.353	0.080	0.000***	1.483	1.259 to 1.748
Abdominal pain (*n*=3452)	6.7	9.7		9.778	0.053	0.001***	1.489	1.159 to 1.914
Backache (*n*=3448)	21.5	26.9		13.299	0.062	0.000***	1.343	1.146 to 1.574
Pain in the neck and shoulders (*n*=3329)	17.8	22.4		10.427	0.056	0.001***	1.330	1.118 to 1.583
Fatigue (*n*=3355)	32.9	46.8		58.181	0.132	0.000***	1.734	1.504 to 1.998
Sadness (*n*=3451)	21.4	26.6		11.654	0.058	0.000***	1.322	1.126 to 1.552
Irritability/bad temper (*n*=3454)	23.3	30.0		17.989	0.072	0.000***	1.400	1.198 to 1.636
Nervousness (*n*=3455)	30.7	37.5		15.839	0.068	0.000***	1.341	1.160 to 1.549
Dizziness (*n*=3452)	8.4	11.0		5.955	0.042	0.008**	1.342	1.059 to 1.702

p<=0.05*; *p*<=0.01**; *p*<=0.001***